SCIENCE

New Series
Vol. L, No. 1298

Friday, November 14, 1919

Single Copies, 15 Cts.
Annual Subscription, $5.00

SCIENCE

Friday, November 14, 1919

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

INDUSTRIAL RESEARCH IN SMALL ESTABLISHMENTS

In the past few years, and particularly during the war, research in connection with industry has had much consideration. Most of our large technical societies have devoted sessions to its discussion and have listened to admirable papers on the subject. I hope not to retraverse the ground thus covered. In this audience the vital importance of research to our technical industries would not need arguing even if it had not been amply argued. In these discussions research has been considered as something to be carried on in large well-organized laboratories, and for that reason possible only for large companies, for associated companies managing a cooperative laboratory or for government laboratories and the like. I believe that this way of thinking of research unnecessarily restricts it, and that differently conceived its usefulness to small as well as large establishments would become evident and might result in its large extension.

The various activities covered by such titles as "Research, Development and Technical Control" are those which should be assumed by a research department in a small business. In order to avoid a cumbersome name for such a department, I want to make a plea for a definition of technical research which some of you may think degrading. Doubtless you are accustomed to thinking of research as an adventure into the realms of the absolutely unknown. A department capable of research in this sense will only be possible in a small business when that business happens to have in it a real scientist. But every technical business (and what manufacturing business is not technical?) is continually confronted with the need of more information than is possessed by its regular staff in regard to processes, characteristics of materials, etc., and if it is to develop realizes that it must find new fields for

its product and find new products to sell. The most advantageous solution of problems of this character can not be left to people who are busied with the routine problems of sales and production. They can best be handled by a staff, even if a very small one, set aside for this purpose. I want to suggest that any department having such functions may be called a research department, and that industrial research may be defined for any given establishment as all that class of work which enlarges the technical horizon of the establishment beyond what is necessary for the routine production and test of its product. You will note that this will make a sharp distinction between a research laboratory and a testing laboratory. I should not want to see a chemical laboratory, however large and elaborate its equipment or however highly trained its staff might be, called a research laboratory if its sole function happened to be routine analysis and check on the product. On the other hand, I should like to see any little room with even a very meager equipment and staff, perhaps only a single individual, called a research laboratory provided the functions of that individual and equipment were solely the improvement of processes, investigation of properties of materials new to the industry, development of new products, etc. And I should want to have it called a research department even if the research be chiefly carried on in libraries or other places for the purpose of bringing information, elsewhere well known, to an establishment to which that information happens to be new. This conception of research widely recognized might be the occasion for many small industries to start research departments, which these industries now regard as possible only for large capital. In this sense many small industries already have individuals with research functions who have other duties as well and do not clearly recognize their research functions. Under these circumstances both the research and the other work suffer, and as the business develops research does not find the best relation to the work as a whole.

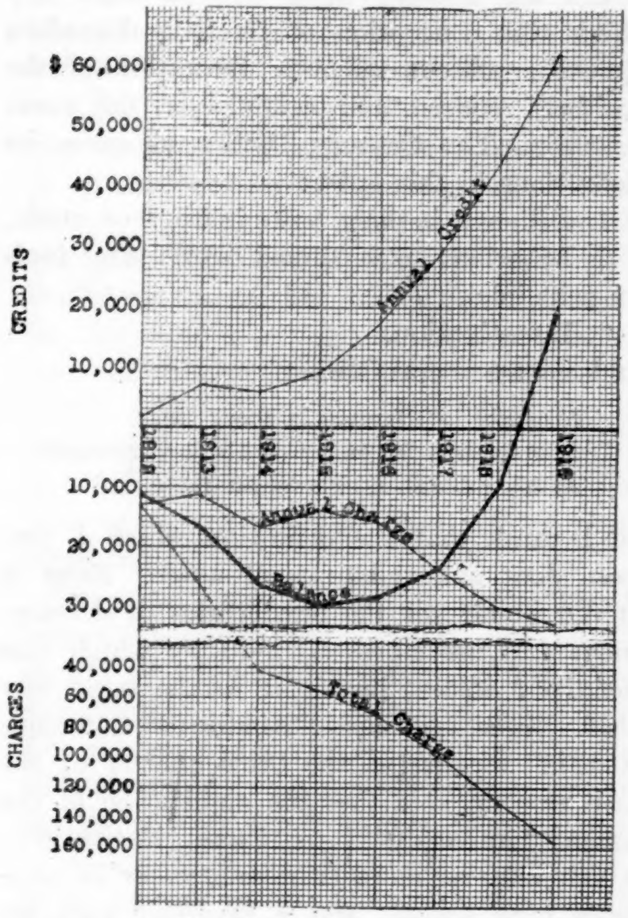
Research, development and technical control merge into each other at many points, and in all but very large establishments can probably best be carried on by a group working under one head. Why attempt lines of demarcation?

In order that research may find its fixed and recognized place in industry it is desirable that it be carefully planned and controlled, and that its results be carefully watched. So far as I know, these two conditions of the successful coordination of research with industry have not been discussed. Control in the sense of control of the research in the laboratory after it has been decided on has had discussion, and I do not refer to it but to the determination of the subjects which shall be investigated in the research department and the decision as to when the research is completed, or, in case it is one that does not lead to satisfactory results, when it shall be abandoned. For some five or six years this class of decisions in connection with our research department has been made by a committee of which the president of the company, the head of the research department, and representatives of the sales, engineering and production departments are members. This committee, called the research committee, meets once in two weeks, passes on all new subjects for the research department to handle, listens to reports on the progress of the work in hand and passes on recommendations in regard to the conclusion or discontinuance of work. In this way the work of the research department is well coordinated with the needs of the business as a whole. As a further factor in coordination the head of the research department is one of the board of directors and sits on the executive committee. The research committee has nothing to do with the internal administration of the department, which is left entirely to its own staff.

Records of the results of a research department can best be kept by the accounting department. It is just as important to know the cost of research as of any other department, and, as in other cases, the usefulness of the record depends to a very large extent on its subdivision. It is worth while to know what investigations contribute to business success and what ones do not.

Some years ago we worked out a plan of determining research cost and making credits to the department which has given us much valuable information. Each investigation undertaken has its cost record kept by the accounting department in the same way that a production order has. We of course do not ask our research men to register their time on a time clock or anything of that kind, but we do ask them to make a memorandum of the work on which they spend their time and turn in to the accounting department once a week a statement of the distribution of their time over the orders running in the department. Similarly, expenses and costs of materials are kept, and when an investigation is closed its total cost is determined. If it happens to be one that has to do with manufacturing processes, such as test of new materials, etc., or development of new methods, it is either charged to general expense or to the expense of some particular product. If, however, it is a piece of work which results in the development of a new instrument or product for sale, it is treated in the same way that a new instrument developed and brought in by an outsider would be. The research committee decides how much royalty can properly be charged to the cost of the instrument, and then as each instrument is made the royalty is added to its cost and is credited against its cost account in the research department. In that way a continuous record of the usefulness of the research to the business is available. In cases of minor importance it is customary to discontinue credits when the cost has been covered. In cases where new products result they are allowed to run on indefinitely. Successful developments accumulate royalties that more than pay for the cost of their research and offset the costs of work that leads to nothing. The diagram shows the relation of annual and accumulated costs of research to the annual and accumulated credits since the department was given a distinct place. In a little over six years the total credits had equalled the total charges and the balance went to the credit side. On the books the account is closed out each year to profit and loss. It is carried forward as a memorandum account only. In the earlier years of the record the total volume of business done by the company was but a few hundred thousand dollars per year.

To summarize, I am making a plea for a



conception and organization of research which will allow it to emerge as a distinct department in any growing technical business and take its proper place just as sales, production and accounting do. Any technical business ambitious to grow and render worthy service must in some way avail itself of research. Kenneth Mees and others have pointed out how industry in the past has developed around invention and research, although the distinctiveness of these functions was not clearly recognized, and in many cases they were not directly associated with the business which profited by them. Certainly an enterprise will have a more worthy and normal growth if its need for research is early and clearly recognized, and the research department will more easily find its proper relation to the business as a whole if it is established early and its place and functions are defined.

After a business has assumed large proportions, and research functions are distributed in scattered manufacturing and engineering departments, it is difficult to gather them together and coordinate them.

Let me remind those of you who may think this conception of research degrading that the present scientific limitation of the word is modern and confined to the exact sciences. The Century Dictionary gives its definitions in this order:

1. Diligent inquiry, examination or study,
2. Laborious or continued search after facts or principles,
3. Investigation,

and quotes from Cowper

> He sucks intelligence in every clime
> And spreads the honey of his deep research
> At his return—a rich repast for me,

so I think that the definition which I propose does not violate good usage. Even if it did would not the possibilities of development and usefulness to industry which this definition allows justify it in the same way that Bryce, in his "American Commonwealth," writing of the third quarter of the last century, said that the application of the name "university" to many institutions, which were no more than colleges or in some cases high schools, was a favorable sign because it showed an aspiration, and that where the aspiration existed the reality would follow? We all know to what a large extent this forecast has come true.

Morris E. Leeds
Leeds & Northrup Company,
Philadelphia, Pa.

THE NATURALIST'S PLACE IN HIS COMMUNITY[1]

Before beginning discussion I may say that I am not trying to say anything new or original and that I am not quite sure that I shall be able to make myself entirely clear in the limited time at my disposal. I do think, however, that the points which I shall mention should be more often opened to serious consideration.

Inasmuch as there are probably about as many different notions of "naturalist" as there are users of the word it may be necessary to say that by this term I now mean any one who is actively interested in living things as such.

In primitive societies most of the leaders are naturalists. In fact in most cases their leadership depends on attainments of that sort. The medicine man gains and holds his position very largely through his shifty use of knowledge of certain characteristics of animals in general and of his fellows in particular. The chieftain also usually bases his influence on successes derived from familiarity with activities of all sorts of animals. Certain women may gain indulgence or even general respect through exceptional familiarity with medicinal and food values of great numbers of plants and animals. It is, of course, easy to see that primitive leadership is thus conditioned because primitive man is individually in contact with the natural environment and appreciative of its mysteries; also because in an unspecialized social group all the members are sufficiently acquainted with every phase of activity to be able to understand and fairly to evaluate unusual skill and intelligence.

As society advances in complexity from the primitive stage and as more and more specialization occurs there are larger and larger numbers of individuals removed from natural to artificial conditions of existence. Not only so, but many of them are so far removed that they cease to have any knowledge of natural existence and so become entirely out of sympathy with those who retain some contact with and some interest in the natural order of things. This remoteness from nature may be physical as in the city dweller, or mental as in the rural resident who sees nothing but a pecuniary return through manipulation of same natural object. Thus it happens that the abilities of the naturalist tend to be obscured, ignored or derided in a complex society. His standing amongst his fellows is reduced to the lowest rank and his influence

[1] Read at the meeting of the Bay Section of the Western Society of Naturalists, Stanford University, November 29, 1918.

nears the vanishing point. It requires peculiar devotion to a cause to face such obscurity and indifference hence those who chose to be naturalists under such conditions are often seclusive, reticent and even indifferent to interests of others.

In recent years there has been a good deal of discussion of the need of considering the wholeness of organisms, of organizations of various social groups, etc. Every one seems ready to concede that we do not know a thing until we know all its relationships and that we do not know an organism or an organization until we know all its component parts. Every one seems willing to concede in the abstract that an organism is not complete if even the smallest part be missing or the obscurest function impaired. Practically when it comes to cases this view is not fully sustained as is well illustrated in case of the naturalist whose talents are insufficiently used and whose valuable point of view is largely ignored. The community as a whole suffers material loss from his submersion.

At this point it may be well to raise the question as to the proper status of the naturalist in our own social order. Should he be expected to take the highest place in leadership? Or a secondary place? Or should he be denied any leadership at all? Intelligent answer to such questions requires some examination of the naturalist's worth to his community or to society at large. Typically a statement of this worth may be brought under the following heads. (1) He may make discoveries which will extend the sources for food, clothing, transportation and manufacture. (2) He may make discoveries which enable better preservation and greater conservation of resources in health and wealth. (3) He may make discoveries which will enable better understanding of the fundamental laws governing the activities of all living things. (4) With his broad outlook he may so organize all available knowledge as to obtain better development of natural resources and better distribution and use of natural products. (5) He may so systematize useful information as to make essential features readily available for specialists with limited time and restricted outlook. (6) He may so condense, simplify and popularize available information as to make it not only usable but to some extent tasteful to those unskilled in scientific thought. Thus the sympathy of his fellows may be extended and their positive support secured. (7) He may be on the lookout for young people with ability who need encouragement to proceed along lines of study in natural history and he may so encourage them. (8) Last, but not least, he may himself give time consistently and regularly to consideration of the problems of his community and of society at large and he may then exert his voice and influence for the things which from his broad viewpoint appear right. Thus he may to some extent act as a balancing power even though he may not have or care to exercise powers of aggressive leadership.

From the foregoing it must appear that the naturalist should be accorded and that he should be willing to assume a place of very considerable importance in our social order. The character of this place will vary materially with conditions. In a small community existing under very simple conditions a naturalist of even modern abilities might be expected in most cases to be dominant in leadership. In a larger, more complex community only one of exceptional ability might reach great prominence. In such a community the naturalist of moderate ability would probably be limited to exerting influence in various ways. His efforts might bring larger results and his life accomplish more than in the smaller community though obscured by his relatively less importance. Here and there are a few naturalists of sufficient general ability to assume leadership in national affairs. It is a matter of great importance that they should be encouraged to do so.

This paper must further concern itself mainly with the naturalist of moderate ability, limited opportunities and restricted field, that is to say the ordinary sort. It seems to me that he ought to be encouraged to think of himself as having an obligation to the community, an obligation beyond the direct results of his scientific work, the obligation of

personal activity and interest in community affairs. This interest might be manifested by public and private discussion of public problems and community affairs. In such discussions the naturalist is peculiarly equipped for seeing the necessity of complete analysis of a question since he himself is repeatedly confronted with complex situations due to a multitude of factors, all of which must be more or less accurately evaluated. He is also able to see the need of giving time for a situation to develop itself since he is so familiar with the fact that Nature is unhurried in her operations whether their duration be seconds or ages. He is able to see the need of caution and accuracy in procedure since he is so frequently confronted with errors due to the impossibility of eliminating chance combinations. That is to say, the naturalist is able to bring to the consideration of a problem those methods which tend to accuracy of judgment and clarity of vision. Certainly any individual who can do this in a community should exert a valuable influence.

Since the members of a highly specialized community have a marked tendency to become narrow, one-sided, and so, to a considerable degree, abnormal, it is very necessary to have some influence in the other direction. This, too, the naturalist may be able to supply to a great extent. Popular talks on natural phenomena in connection with schools, churches or other organizations may be made of value. Pictures may be largely used for this purpose. Ordinary conversations may often be turned to advantage along this line. Simple exhibits of various sorts may be possible. Any method which will induce even superficial acquaintance of the general public with the great world of life is of distinct advantage from the standpoint of the human community however it may be from the scientific standpoint. Note particularly in this connection that the beneficial effect is reciprocal, *i. e.*, the narrow are broadened, the one-sided more rounded and the abnormal made more nearly normal on the one hand, while on the other hand the naturalist is stimulated, pleased and supported in his work, both financially and morally in a way not before possible.

Since there may be some who are still wondering what is the object of this paper I may call attention to the fact that we have to-day some very strong evidence pointing to the view that the day of individualism is rapidly passing and that the day of collectivism (of some sort) comes on apace. It is no more permissible for the man of science to shut himself up in his own interests and to assume an air of lofty indifference to the aims and aspirations of other people than it is for the business or professional man to do so. It is time for the man of science to take some cognizance of public affairs and to assume an active part therein, however small, no matter how much he may be tempted to go into his laboratory or his woods and fields and to ignore the general interests of humanity. It seems to me not at all beneath the dignity of such a body as this to consider ways and means of getting in closer touch with the people about us, of arousing their interest in us and our interest in them, and thus contributing our share toward the harmonizing of society as a whole. I feel certain that there are hundreds of people in this state who ought to have some interest in some or all of the things which we as individuals are doing. I think our state would be a better state if there were some understanding of that sort. It seems to me that we are too much disposed to let the especially able men like Dr. Jordan, Dr. Ritter, Dr. Evermann and others do what they can and to feel that we ourselves are thereby relieved of obligation. I do not think that is a correct attitude. If we want to have the general public respond as it should to the call for progress in scientific matters, we must each be willing to sacrifice some prejudice, some leisure and some effort for the good of the cause. I think too that we should collectively look over the field and consider the possibility of instituting or extending some activity that will help. What I have said simply indicates some of the lines along which I think activity might possibly be directed.

In conclusion, let me say that I think the naturalist ought to fill in his community a place of influence or of leadership, that be-

cause of his qualifications he ought, if necessary, to seek such a place, and that an organization of naturalists ought to definitely consider ways and means of extending its influence as far as possible.

This is a day of propaganda. The unworthy type will prevail if it is not overridden or displaced by the worthy type. Any and every learned society is under constructive obligation to do what it can in such a cause, but we must always remember the danger of attempting anything of the sort without first eliminating all traces of pedantry.

W. E. Allen

Scripps Institution,
La Jolla, Calif.

CHARLES CONRAD ABBOTT AND ERNEST VOLK[1]

The recent death of Dr. C. C. Abbott and Mr. Ernest Volk[1] of Trenton, New Jersey, removes two investigators whose work must always occupy a prominent place in attempts to estimate the conditions and chronology of prehistoric man. Not long after the discovery of palæolithic implements in northern France and southern England establishing the existence of man in Europe before the close of the Glacial period, Dr. Abbott began reporting the discovery of implements of similar type in the gravel deposits of glacial age upon which the city of Trenton is built. The first report of his discoveries was made to the Smithsonian Institution in 1875. Between 1875 and 1888 he had found sixty such specimens in the undisturbed gravel at various depths, some of which were as much as twenty-two feet from the surface.

As a resident of Trenton, Mr. Volk's attention was naturally called to Dr. Abbott's discoveries at the outset; but it was not until the fall of 1889 that he began systematic work, under the direction of Professor Putnam, for the Peabody Museum of Harvard University. His services continued for twenty-two years. The result of his long exploration of the Trenton gravels was published in 1911, in Volume V. of the Papers of the Peabody Museum of American Archæology and Ethnology. The report proper fills 258 octavo pages, which summarizes his journals from 1889 to 1905, and after that gives his journal in full, in which every day's work is carefully recorded. This fills one hundred pages. There are one hundred and twenty-five photographic illustrations.

In 1880, I was requested by Professor Putnam and Asa Gray to visit Trenton in the interests of the Peabody Museum, to shed what light I could upon the character of the gravel deposits in which palæolithic implements had been found by Dr. Abbott. This I did in company with Professor Boyd Dawkins, of England, who was then in Boston giving a course of Lowell Institute lectures, and Professor Henry W. Haynes, who had made collections from all the fields in Europe and in Egypt where palæolithic implements are found, and with Mr. H. Carvill Lewis, a glacialist of the highest reputation, who afterwards was joined with me in the survey of the terminal moraine across the state for the Pennsylvania Geological Survey; and whose report on the Trenton gravels published as an appendix to Abbott's "Primitive Industry" establishes beyond question the late glacial age of the deposit. Since then I have visited the region almost every year and some years several times, and at two different times spent days together with a committee appointed by the A. A. A. S. to make explorations. It is therefore proper that I should speak in defense of the discoveries, especially of Dr. Abbott and Mr. Volk in view of the fact that persistent attempts have been made to discredit them.

The chief reason for doubting the accuracy of these observations appears to have been that while Dr. Abbott and Mr. Volk had made so many discoveries, hardly anybody else has made any. But to this objection it is sufficient to say that Dr. Abbott and Mr. Volk have had a thousand opportunities to make discoveries where other investigators

[1] A notice of Dr. Abbott's death was given in Science, September 12. Mr. Volk was badly injured in an automobile accident on September 15 and died without recovering consciousness, two days afterwards.

have had but one. The railroad station at Trenton is twenty or twenty-five feet below the surface of the gravel and for years the railroad was continuously at work in excavating the gravel for ballast until they had removed many acres, thus exposing new perpendicular faces of the gravel for inspection every day for several years. As it is the early bird that catches the worm, so it is the early observer who notes the facts, and Dr. Abbott was such an observer. Every day for years, and sometimes two or three times a day, as he went to and fro, he observed these excavations, and his eye soon became trained so that no facts could escape his observation.

At the same time Mr. Volk was engaged for twenty-two years, not only in observing excavations made by other parties but in personal excavations in which many acres were dug over to a depth of about four feet, and everything carefully observed and noted. Mr. Volk's investigations were at last rewarded by the discovery of part of the shaft of a human thigh bone, seven feet and a half below the surface, where there had been no disturbance of the strata. He photographed this in place; and soon after, in the same stratum, found fragments of a cranium. A recent lecturer of high reputation as an anatomist has attempted to discredit this last discovery of Mr. Volk on two considerations, first that he was too much of an enthusiast to make accurate observations; and secondly that this bone is of the type of the modern Indian and therefore could not be so old as glacial gravels are supposed to be.

In answer to this it is sufficient to refer the reader to Mr. Volk's report just mentioned, which is all in the most plain and matter-of-fact style and is accompanied by one hundred and twenty-five plates made from his photographs. If ever I associated with an investigator who attempted to state facts just as he saw them, it was Ernest Volk. The principal reason for discrediting Mr. Volk's discovery is a theoretical one which is far from being established. The critic thinks the bones belong to a race more recent than the glacial deposits. But in the first place, there are current grossly exaggerated estimates as to the date of the close of the Glacial period. The Swedish geologists are producing incontrovertible evidence that it is less than 7,000 years ago since the ice retreated from southern Sweden; and there is a respectable number of geologists of wide experience in this country who think they have conclusive evidence that the close of the Wisconsin epoch in America occurred less than 10,000 years ago. In the second place Dr. Keith, the leading comparative anatomist of England, maintains that present types of the human skeleton go back in Europe to very much earlier times than can properly be assigned to the Trenton gravel. The permanence of racial peculiarities is by no means a settled question. Instead of denying facts on the basis of a theory involving a rapid rate of change in specific anatomic characteristics, facts should be allowed to modify the theory.

There is also abundant circumstantial evidence of the most positive kind sustaining the testimony of Dr. Abbott and Mr. Volk. For example, with two or three exceptions (which prove the rule), all the artifacts reported by them as found in the Trenton gravels below the disturbed surface of ten or twelve inches are of palæolithic type and made from argillite; while in the upper ten or twelve inches innumerable artifacts are found of modern Indian type, chipped from flint and jasper, with an occasional piece of pottery. This proves conclusively that the argillite implements belong to the original stratification of the gravel. No reason can be given for intrusive burials of argillite that would not be accompanied also by flint and jasper. Some, however, had supposed that these argillite fragments had worked down into the lower strata through the decayed roots of trees, or through holes made by burrowing animals, or through disturbances of the soil by the overturning of trees, or through cracks in the soil that occur in dry weather. All these theories have been urged; but this soil does not crack in dry weather, and the argillite fragments are larger and lighter than the flint and jasper and would not so readily follow down the cavity of

decayed tree trunks as would the other materials.

In 1897 I was asked by the A. A. A. S. to go down with a committee of the Society to inspect Mr. Volk's work. This I did in company with Mr. H. C. Mercer, Professor Arthur Hollick, of Columbia University, and Professor William Libbey, of Princeton. Five days were spent upon the ground. Mr. Volk ventured (what is a very hazardous thing for a scientific man to do), to prophesy what we should find. He let us select our ground, which we did in several places, and had extensive excavations made under our own eyes. What Mr. Volk prophesied was that in the upper foot of disturbed soil we should find numerous artifacts of flint and jasper and some pottery, but that below that we should find nothing of that kind but would find occasionally worked pieces of argillite. This proved to be exactly the case. We found in the lower portion of our excavation sixteen chipped fragments of argillite, all covered with deep patina. We found also some broken pebbles which had been battered to indicate use by man. We also found five flakes of quartz which may have been used as implements but were of an entirely different type from those on the surface. All this accorded with the general facts as reported by Mr. Volk, and to us were perfectly convincing evidence of the accuracy of his observations, and confirmatory of the testimony of Dr. Abbott concerning the prevalence of argillite in the undisturbed glacial strata, establishing a sharp distinction between the occupation of palæolithic man and that of the aboriginal Indians.

The work of Dr. Abbott and Mr. Volk illustrates the importance of having local observers interested in discoveries to be made about their own doors. They were both business men who turned aside to make and record observations which could be made only by those who were on the ground; and their observations have been carefully recorded and published, and their collections preserved where they are open to the observation of all scientific men, namely in the Field Museum of Natural History in Chicago, the American Museum of Natural History in New York City, but more than anywhere else in the Peabody Museum in Cambridge, Massachusetts. Aside from the volume already noted, Mr. Volk published reports of his early discoveries in the proceedings of the A. A. A. S. in 1894 and in the *Mem. Intern. Congress Anthropology,* 1894. In addition to "Primitive Industry" Abbott's discoveries are recorded in *Rep. Smithsonian Inst.,* 1875; "The Stone Age in New Jersey," 1877; *Rep. Peabody Museum,* 1877 and 1878; *Proc. Boston Soc. Nat. Hist.,* 1881 and 1883; *Am. Naturalist* (Extra), 1885; *Proc. A. A. A. S.,* 1889; *Archæologia Nova Cæsarea,* 1907, 1908, 1909.

G. Frederick Wright

Oberlin,
October 6, 1919

SCIENTIFIC EVENTS

INTERNATIONAL SCIENCE AND THE WAR

An appeal has been addressed to the members of the academies of the allied nations and of the United States by 177 members of the academies of neutral nations—Holland, Norway, Sweden, Denmark, Finland and Switzerland—represented in the International Association of Academies, the opening and concluding paragraphs of which are as follows:

In the autumn of 1813, when for years a most bitter war had been raging between France and England, the English chemist Humphry Davy set out for Italy via Paris. His biographer relates what follows about his experiences in the French capital: "Nothing could exceed the cordiality and warmth of Davy's reception by the French savants. On Nov. 2nd he attended a sitting of the First Class of the Institute and was placed on the right hand of the President, who announced to the meeting that it was honoured by the presence of 'le chevalier Davy.' Each day saw some reception or entertainment in his honour. . . . On Dec. 13th, 1913 he was with practical unanimity elected a corresponding member of the First Class of the Institute."

On October 2, 1918, when a most bitter war raging between France and Germany for four years had practically come to an end, it is stated in a meeting of the French Academié des Science, that "elle a été unanime à déclarer que les relations personnelles sont pour longtemps impossibles entre les savants des pays alliés et ceux des empires cen-

traux," so that "nous devons abandonner les anciennes associations internationales, et en créer de nouvelles entre alliés avec le concours eventuél des neutres."

Whence this painful contrast? We should rather have expected the opposite, even without indulging illusions with regard to the progress of mankind during a hundred years. For there seems to be more room for generosity when the war's misery is past than when it is still raging; more too towards a defeated enemy than towards one who is still to be feared.

. . . .

Summing up what precedes we ask you earnestly and urgently: Recover your former selves. Recover the high scientific point of view which, on his deathbed, made Ampère say to a fellow worker: "il ne doit être question entre nous que de ce qui est eternel!" Once more: we understand how your attention of late has been monopolized by what is temporal and transitory. But now, you more than all the others, are called upon to find again the way to what is eternal. You possess the inclination for objective thought, the wide range of vision, the discretion, the habit of self-criticism. Of you we had expected the first step for the restoration of lacerated Europe. We call on you for cooperation in order to prevent science from becoming divided, for the first time and for an indefinite period, into hostile political camps.

THE LEAGUE OF RED CROSS SOCIETIES

WE learn from *The British Medical Journal* that the headquarters of the League of Red Cross Societies, which was formed in Paris, on May 5, 1919, are at 9, Cour de St. Pierre, Geneva, and the work of organization is proceeding as rapidly as possible. The founder members of the League were the American, British, French, Italian and Japanese national Red Cross societies. The following national societies have since become members, Argentina, Australia, Belgium, Brazil, Canada, China, Cuba, Denmark, Greece Holland, India, New Zealand, Norway, Peru, Portugal, Rumania, Serbia, South Africa, Spain, Sweden and Venezuela.

The third number of the *Bulletin* of the League gives a list of the officers and heads of departments who have already been appointed and have taken up their duties at head quarters. The director-general is Lieutenant-General Sir David Henderson; the secretary-general is Professor William E. Rappard; the treasurer-general is M. André Pallain; the general medical director is Colonel Richard P. Strong, with Dr. Leonard Findley as director of the department of child welfare; the counsellor in international public health is Professor Rocco Santoliquido. In the departments of public health and hygiene bureaus will be organized to deal with the subjects of child welfare, tuberculosis, malaria, preventive medicine, venereal diseases and nursing.

An Inter-Allied Medical Commission was recently sent by the League at the request of the Polish government to investigate the pandemic of typhus fever in Poland. One of the gravest consequences of the devastation of Poland during the war has been the great decline in the sanitary condition of the Polish population, with a concurrent rise in the general mortality. The Inter-Allied Commission will report on the sanitary conditions in Poland, and will make recommendations as to the advisability of establishing sanitary cordons to suppress the spread of typhus into adjacent territories. When the commission has issued its report the League will be in a position to devise relief and preventive measures in the countries concerned, to propose to the Red Cross societies interested in the work an active sanitary campaign, and to urge the necessary measures that should be undertaken by the governments themselves. It is believed that the Polish pandemic of typhus originated in Russia and Ukrania.

The reports of the various sections of the medical conference held at Cannes in April last have now been published. They are printed in English, French, Italian and Spanish, and may be had on application to the Department of Information and Publication of the League.

THE TARIFF ON SCIENTIFIC APPARATUS

THE *Journal* of the Washington Academy of Sciences states that the finance committee of the Senate, which has had before it the bill for a tariff on scientific supplies (H. R. 7785), decided on October 3 to postpone all

revenue and tariff matters until after the treaty of peace had been acted upon.

During the hearings on the bill the Tariff Commission prepared a report entitled *Information concerning scientific instruments,* which has been recently published. The report brings together a large number of opinions and arguments concerning the tariff on scientific supplies, received from various sections of the Bureau of Standards, from manufacturers and instruments of all kinds and from universities and organizations.

Two distinct questions are involved: (1) Should Congress repeal the privilege, now granted to institutions of learning, of importing supplies free of duty? (2) Should the present rates be increased and imported articles now on the free list be taxed?

The opinions quoted are not analyzed in the report, but the following brief outline will indicate that those interested are still far from being in agreement. (Definite recommendations only are counted.)

1. Of eleven university professors quoted, one favors and ten oppose repeal of the duty-free clause. Of twelve opinions from the Bureau of Standards, five favor and seven oppose repeal. Of seven manufacturers quoted on this subject six favor and one opposes repeal. The Council of the American Chemical Society is quoted in favor of repeal of the duty-free clause, "for a reasonable period of years, at least."

2. Opinions on the subject of the imposition and increase of tariff rates on scientific supplies are quoted as follows: Ten manufacturers, all in favor of higher tariff; eleven sections of the Bureau of Standards, seven in favor and four against. The commission believes that "the extremely diverse nature of the products falling under such a general designation as 'scientific instruments' renders general statements concerning the entire group of little value for the purpose of deciding on any rates of duty related to the competitive conditions which affect individual instruments."

The report also discusses in a general way the status of the domestic industry, imports and exports, tariff history, competitive conditions and war developments.

THE NEW YORK BOTANICAL GARDEN

There was formally opened at the New York Botanical Garden on November 8 a new Central Display Greenhouse, the gift of Daniel and Murray Guggenheimer, erected at a cost of $100,000. The gift includes, besides the main house, an adjoining orchid house. The main building is approximately 140 feet long, forty-five feet wide and thirty-five feet high. Among its new features is the glass, which is frosted, thus doing away with the use of screens, previously considered necessary in glasshouses, although more or less of a disfigurement, as they become quickly defaced. The new building has an open concrete floored center, where lectures are to be given.

The central display house will contain plants from South Africa, the southern part of Japan, from South America and from some of the southern states in this country. A special exhibition of plants and flowers was shown. The Horticultural Society of New York held a large flower show in the new greenhouse which is now open to the public. It is on the eastern end of the grounds, near the Allerton Avenue subway station, and will aid in distributing the crowds visiting the gardens, the other group of greenhouses being at the western end of the grounds.

W. Gilman Thompson, president of the board of directors of the garden, opened the exercises and told of the educational work of the garden, a part of which will now be done in the new building. The gift of the greenhouse, he said, with the exception of one by Mrs. Russell Sage, was the largest ever made to the garden. Dr. N. L. Britton, director of the Botanical Garden, and Dr. D. T. MacDougal, director of botanical research, Carnegie Institution of Washington, formerly assistant director made addresses.

GIFT TO THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

Announcement is made that Mr. John D. Rockefeller has added $10,000,000 to his previous endowment of the Rockefeller Institute for Medical Research. This gift, the largest made by Mr. Rockefeller at one time to the institution, is to meet rapidly growing needs in its many lines of research and in

making new knowledge available in the protection of the public health and in the improved treatment of disease and injury.

By this increase in the endowment, new lines of research will be sustained in biology, chemistry and physics, upon which medical science so largely rests, as well as in medicine itself, as will the study of many practical problems directly relating to diseases in men and animals which are already under way.

The local activities of the Rockefeller Institute in New York are chiefly carried on in the great laboratories and the hospital, which stand high on the bluff facing the East River, between East 64th and 67th Streets, a part of the old Schermerhorn Farm of an earlier day.

Near Princeton, N. J., the institute has a large farm, where it maintains a department of animal pathology. The laboratories and various accessory buildings here are devoted to research on the diseases of animals and effective methods for their prevention and cure, as well as to the study of the bearing of animal diseases upon the health and economic interests of man.

The scientific staff of the Rockefeller Institute numbers sixty-five, most of them highly trained and of large experience in the subjects to which they are exclusively devoted. The institute further employs 310 persons in its technical and general service. It is to the perpetual maintenance of such a group of men and women, with adequate facilities and suitable conditions for their successful work, for the general welfare, that the gifts of Mr. Rockefeller to the institute are devoted.

The scientific staff consists of members, associate members, associates and assistants. The members are:

Simon Flexner, pathology and bacteriology; director of the Laboratories.
Rufus Cole, medicine; director of the Hospital; physician to the Hospital.
Theobald Smith, director of the department of animal pathology.
Alexis Carrel, experimental surgery.
P. A. Levene, chemistry.
Jacques Loeb, experimental biology.
S. J. Meltzer, physiology and pharmacology.
Hideyo Noguchi, pathology and bacteriology.

SCIENTIFIC NOTES AND NEWS

Charles Henry Hitchcock, for forty years professor of geology at Dartmouth College, died on November 6, at Honolulu, aged eighty-three years.

Mr. Richard B. Moore, until recently stationed at the Bureau of Mines' experiment station at Golden, Colorado, has been appointed chief chemist of the bureau, to succeed Dr. C. L. Parsons.

The degree of doctor of philosophy has been conferred upon Dr. Bohumil Shimek, professor of physiological botany in the State University of Iowa, by the University of Prague in appreciation of his scientific work. Dr. Shimek lectured in Prague in 1914.

Vilhjalmur Stefansson has been awarded the La Roquette Gold Medal of the Geographical Society of Paris, in recognition of the discoveries made by the Canadian Arctic Expedition under his command during the years 1913-18.

The Royal Institute of Venice has awarded the Querini-Stampalia prize to Professor G. D. Birkhoff, of Harvard University, for his papers on "The restricted problem of three bodies," and "Dynamical systems with two degrees of freedom."

Professors P. Boutroux and J. H. M. Wedderburn returned from military service to Princeton University at the opening of the present academic year.

We learn from *Nature* that Mr. Francis Jeffrey Bell, who has just retired from the Natural History Museum under the age-limit, entered the service of the trustees in 1878, when the zoological department was still at Bloomsbury and Professor Owen the superintendent. Mr. Bell is emeritus professor of comparative anatomy in King's College, London, and he served for many years as one of the secretaries of the Royal Microscopical Society, the *Journal* of which he also edited. In 1898 he acted as general secretary of the International Congress of Zoology.

Proessor S. H. Vines proposes to retire from the Sherardian professorship of botany

in the University of Oxford at the end of the current year.

MR. F. J. KATZ has been granted leave of absence from the Mineral Resources division of the U. S. Geological Survey in order to accept an appointment as expert special agent in charge of Mines and Quaries for the Bureau of Census. This arrangement is to insure close and effective cooperation between the two bureaus in the Fourteenth Census.

MR. O. J. R. HOWARTH, assistant secretary of the British Association for the Advancement of Science, is making a collection of materials for a history of the association.

MR. JOHN B. FERGUSON has presented his resignation from the Geophysical Laboratory, Carnegie Institution of Washington, to be in effect November 1, and has accepted a research position with the Western Electric Company in New York City.

CHARLES BARTO BROWN has resigned as professor of civil engineering at the University of Maine and is now associated with The Frederick M. Ward Company in New Haven, Conn.

DR. F. W. SKIRROW, for the past four years assistant professor of chemistry at McGill University, has resigned this position to become chief chemist to the Shawinigan Laboratory, Ltd., the newly founded research organization of the Shawinigan Water and Power Co., Shawinigan Falls, Que.

DR. W. W. ROBBINS has resigned as professor of botany and botanist at the Colorado Agricultural College and Experiment Station to accept a position in the experimental department of the Great Western Sugar Company, with headquarters at Longmont, Colorado.

MR. BERRY V. BUSH, formerly head of the chemistry department at Friends Central School, Philadelphia, has been appointed research chemist in the organic research laboratories of the Eastman Kodak Co., Rochester, N. Y.

DR. L. A. BAUER, after returning to England from his eclipse expedition to Cape Palmas, Liberia, represented the United States Weather Bureau at a preliminary conference of directors of government weather bureaus of allied and neutral countries, called by Sir Napier Shaw at the British Meteorological Office, July 3-9. Later, as one of the United States delegates, he attended the meetings of the International Research Council and of the International Geodetic and Geophysical Union at Brussels from July 18 to 30. Since his return to the United States at the end of August, he has presented papers before various societies on the eclipse of May 29, 1919, and his experiences in Liberia. On December 2 he will deliver an illustrated lecture before the Royal Astronomical Society of Canada and the University of Toronto on the eclipse of May 29, 1919 and the researches of the Department of Terrestrial Magnetism. Besides photographs secured at his own station at Cape Palmas, he has received copies of photographs from the various expeditions along the belt of totality, from Bolivia to the French Congo.

JAMES R. CRAWFORD, of New York, one of the two members of the Stefansson Arctic expedition who were left on Banks Island two years ago, has arrived from the far north on the auxiliary schooner *Herman*. Mr. Crawford told of the hardships he endured during his forced stay of two years on Banks Island. His one attempt to reach the mainland in a small launch left by Mr. Stefansson met with failure in the ice floes.

DR. O. OLSEN proposes to conduct a small Norwegian anthropological and botanical expedition to Siberia next spring. His plan is to go to the Yenisei valley north of Krasnoyarsk, and to push thence into the less known regions immediately to the east.

THE tenth course of lectures on the Herter Foundation is being given at the Johns Hopkins University by Henry Hallett Dale, F.R.S., director of the department of biochemistry and pharmacology, Medical Research Committee on National Health Insurance, London. The subjects of the three lectures are: November 13, "Capillary poisons and shock"; November 15, "Anaphylaxis"; November 15, "Chemical structure and physiological action."

Professor I. Newton Kugelmass, head of the department of chemistry in Howard College, addressed on November 1 some of the southern chapters of the American Association of Engineers at the general meeting under the auspices of the Birmingham chapter on "Associationometry."

A monument erected in memory of Surgeon-General George Miller Sternberg, at the National Cemetery, was unveiled on November 5, and remarks were made by Surgeon-General Merritte W. Ireland, U. S. Army, Brigadier-General Walter D. McCaw, Colonel Edward L. Munson and Colonel Frederick F. Russell, Army Medical Corps, and Dr. George M. Kober, of the George Washington University.

The Weir Mitchell oration was delivered by Dr. Charles W. Burr, at the College of Physicians of Philadelphia, on November 1. The subject was "Dr. S. Weir Mitchell as a physician, a man of science, a man of affairs, and a man of letters."

UNIVERSITY AND EDUCATIONAL NEWS

Two industrial fellowships in the department of botany have just been established by the Gypsum Industries Association at the University of Chicago. Each fellowship provides a stipend of $750 and also $300 for the purchase of special material and apparatus. The Fleischmann Company has renewed the fellowship in the department of physiological chemistry which was established in 1917. The income of the fellowship provides $750 a year for two years.

Dr. Walter L. Niles, of New York, has been appointed dean of the Cornell Medical School in New York City, to fill the place left vacant by the death of Dr. William M. Polk.

Thomas Smith, lately professor of physics and head of the department of physics in the division of industries of the Carnegie Institute of Technology, has accepted the position of assistant professor in the department of mechanical engineering of the Massachusetts Institute of Technology. Professor John David, formerly assistant professor of physics in the division of industries of the Carnegie Institute of Technology, has been appointed professor of physics in Adelphi College, Brooklyn, N. Y.

Dr. R. R. Renshaw, formerly associate professor of organic chemistry at Iowa State College, has accepted an assistant professorship of chemical research in pharmacology at the Harvard Medical School, Boston.

Dr. Harold Hibbert, of Mount Vernon, New York, has accepted an appointment of assistant professor of chemistry in Yale University. Dr. Hibbert's work will be chiefly in the graduate school, where he will assist Professor T. B. Johnson in the teaching of organic chemistry and directing advanced research in this subject.

It is announced in *Nature* that a new chair of physical chemistry has been established in the University of Bristol on the endowment of Lord Leverhulme. Captain J. W. McBain, lecturer in physical chemistry in the university since its foundation, has been appointed to the chair.

DISCUSSION AND CORRESPONDENCE

SUBSTITUTES FOR THE WORDS HOMOZYGOUS AND HETEROZYGOUS

To the Editor of Science: Those who have attempted to explain the fundamentals of genetics to live-stock breeders and to others with a natural distaste for terminological refinements are aware how ineffective some of the available nomenclature is for this purpose. A technical word to be successfully applied to a new idea in a non-technical discussion must suggest its meaning readily, must be free from misleading connotations and should be sufficiently novel so that the point will not be missed by the audience owing to a spurious aspect of familiarity. That the words homozygous and heterozygous are admittedly defective on the first count is shown by the number of evasions to be found in the literature, but it has not been generally recognized that all their substitutes in common use fail in the other two particulars. To prove this statement requires little more than a list

of the common substitutes. For homozygous these are pure and pure-bred and for heterozygous, impure, mixed, hybrid, mongrel,[1] and cross-bred. These terms all designate, rather loosely to be sure, types or methods of mating or progeny of particular matings. The objections to the appropriation of these terms by Mendelists are many. Mendelists do not hold that a knowledge of an individual's origin is an accurate guide to its breeding behavior; the terms indicate that they do. The careless handling of these expressions causes needless concern to those interested in maintaining pure-bred stock, the very class of persons with whom geneticists should set up cordial relations. Confusion results from the dual meanings since in spite of the attempted re-definitions, it is still necessary for geneticists to speak of the different types of mating in the time-honored way. It is absurd to use impure or hybrid in treating of sex-linked inheritance and other forms of obligatory heterozygosis associated with pure breeding. The familiarity of these expressions make it appear that there is nothing particularly new in the distinction between homozygosity and heterozygosity, the recognition of which is perhaps the chief practical addition of genetics to the breeder's store of ideas. The indictment might be further extended, but enough has been said to show that the objection to these substitutes is not captious, but based on practical considerations.

I recognize that the use of these terms began with the early Mendelian work on plant material. The practise perhaps does not appear incongruous to the plant breeder, but it is time that the well-meaning popularizer should be made to realize that from the standpoint of animal breeding these words have much the same kind of appropriateness as "registered" would have as a substitute for homozygous and "grade" as a substitute for heterozygous. The sooner the misfits are banished, the sooner will we see the spread of a sensible appreciation of genetics in live stock circles. The need of discarding them far outweighs any possible inconvenience that would result from the necessary use of homozygous and heterozygous on all occasions, but the task would be lightened if a satisfactory series of alternatives were available for popular discussions. The object of this communication is to point out that by reviving and extending a usage introduced by Mendel himself, we can readily secure such a series.

Early in his 1865 paper, after demonstrating the 3 : 1 ratio, Mendel makes his first distinction between homozygotes and heterozygotes in these words: "Das dominirende Merkmal kann hier eine doppelte Bedeutung haben, nämlich die des Stammcharakters oder des Hybridenmerkmales." Throughout the paper he consistently refers to heterozygotes as hybrids—thus giving rise to our own unfortunate practise—but as soon as he has presented data showing the true nature of the F_2 ratio, he begins gradually to speak of the homozygotes, whether dominant or recessive, not as plants showing the parental character, but as those having the special trait of remaining constant in successive generations. "Sie besitzen nur constante Merkmale und ändern sich in den nächsten Generationen nicht mehr." His use of "constant" is indeed so insistent as to suggest that he intended to give to this adjective the technical meaning we attach to homozygous. Certainly our word might be substituted for his in passage after passage without making the slightest alteration in the sense or necessitating a textual change. Moreover in one place at least he makes constant a noun using it as the precise equivalent of homozygote. My suggestion is then that we follow Mendel in using *constant* for homozygous and homozygote, but that we use *inconstant* to replace his hybrid in the sense of heterozygous and heterozygote. The words *constancy* and *inconstancy* would then be available for abstract discussions, and if any one objected to the use of constant and inconstant as substantives, he could adopt

[1] Not common but used by Bateson on several occasions, including his address as president of the British Association for the Advancement of Science (1914). Employment of this term in America would add further to the undesirable implications owing to the bracketing of "scrubs and mongrels" in the stallion laws of several states

the expressions *constant form* (frequent in Mendels paper) ard *inconstant form.*

The proposed terms are simple, easily remembered and not spoiled by previous functioning in the literature of plant or animal breeding. They imply nothing as to the origin of the zygote, thus eliminating any possible suggestion that homozygous individuals necessarily arise from pure-breeding and heterozygous ones only from mixed breeding. The word constant conveys the valuable impression that there is a dependability in the germ cell formation of the homozygote, but it will be necessary to give warning that the word inconstant is not meant to suggest complete lawlessness in the breeding results of the heterozygote. However the word heterozygote itself and all substitutes hitherto proposed are defective in that none of them gives a hint as to the law of gamete formation in heterozygotes. While *inconstant* is thus open to the objection that it might convey misformation, it obviously emphasizes a point of essential importance to the breeder. Hybrid and other substitutes also require a word of explanation, since many hybrids are popularly supposed to breed true, but to retain such an impression would be worse than suggesting excessive irregularity. In short, the new terms if adopted would derive much of their value from the fact that a breeder will be quick to realize which kind of individual he wants in his herds or flocks and will thus be interested in knowing how the two types arise.

It is to be hoped that these two words or similar inoffensive ones will be accepted or at least not repudiated by professional geneticists. Some sort of agreement—either by common consent or by general indifference—will be necessary before the conscientious expounder may introduce the words to an audience without mentioning their technical equivalents.

Nothing in this note must be interpreted as a desire to displace homozygous and heterozygous or cognate forms from the technical literature.

Frank J. Kelley
States Relations Service,
U. S. Department of Agriculture

SOME PORT HUDSON OUTCROPS IN LOUISIANA

The Port Hudson beds, so named by Hilgard from their exposure at Port Hudson, La., consist for the most part of beds of clays, usually bluish or black but occasionally yellowish in color. At Port Hudson, La., the type locality, the lower beds consist of black to bluish tenacious clay with frequent logs, stumps and fragments of wood, mostly cypress. At St. Francisville, La., nine miles northwest of Port Hudson, the black, cypress bearing clays outcrop at Black Hill, one half mile east of the town with the following section:

20–25 feet of loess.

4 feet of waxy black and brown tenacious clay with fragments and limbs of cypress, Port Hudson.

2 feet of massive gray and brown sands with scattering sub-angular chert pebbles, probably Lafayette.

The upper beds of the Port Hudson were evidently eroded before the deposition of the loess. The black clay lies uncomformably on the Lafayette below with very sharp line of contact. Apparently the same black clay bed is to be seen in the bed of Scott Creek, near Laurel Hill, La., about 21 miles north of Port Hudson and 3 miles south of the La.-Miss. line. Evidently the lower Port Hudson beds in places underlie the western Florida parishes of Louisiana and probably also the adjacent southern counties of Mississippi.

F. V. Emerson
Louisiana State University

QUOTATIONS

THE RECOMPENSE OF SCIENTIFIC WORKERS

We are very glad to hear that the Science Committee of the British Medical Association has elected a sub-committee to confer with the British Science Guild and other bodies "in the matter of the inadequate recognition and recompense by the government and other bodies of medical workers in the field of science." We are also glad that the Science Guild is nominating some of its members to confer with this sub-committee of the British Medical Association. The members are as follows: For the British Medical Association,

Sir Clifford Allbutt, K.C.B., F.R.S., Dr. R. T. Leiper, Professor Benjamin Moore, F.R.S., Mr. E. B. Turner, F.R.C.S., Professor J. S. Haldane, F.R.S.; and for the British Science Guild, Professor Bayliss, F.R.S., and Dr. Somerville (Chairman and Secretary of the Guild's Health Committee), Sir Alfred Keogh, G.C.B., and Sir Ronald Ross.

We have called attention to this matter in *Science Progress* over and over again, without any definite result hitherto. There is unlimited talk just now about the encouragement of science, but the vital point is almost always omitted. This point is that, unless you make it worth their while for men of great abilities to investigate nature, they will in many cases not be able to do so even though they have the strongest inclination in that direction. We are now spending large sums of money for scientific work, but most of it goes in providing laboratory facilities and small salaries to junior men for "pot-boiler work." This is certainly essential, and we lodge no objection to such expenditure; but, in addition, we must pay adequately for the best possible brains. There is only one way to do so—by paying for discoveries which have already been made. There is really no other way of detecting the best possible brain when it exists. The proof of the pudding is in the eating, and, of the best brain, in the result obtained by it. We therefore think that the world should organize a system of pensions, not only for medical, but for all work which has been of great value to the public at large without being remunerative to the worker. Such a thing is only common sense, common justice and common morality.

The case of the medical scientific worker is the strongest of all. Few people recognize that medical science brings in almost no payment even when it results in discoveries which are really revolutionizing civilization. The fact is that, of all great events in history, perhaps none exceed in importance the discoveries made during the last century regarding the nature of human diseases and their prevention and cure. Yet the people who have made these discoveries have generally lived, we might almost say, in extreme poverty. We believe that the salaries of pathological professors amount generally to only a few hundred a year, and seldom, if ever, exceed one thousand pounds a year. Even these posts appear to be seldom given to men who have themselves made leading medical discoveries. Some people seem to think that such men are remunerated by medical practise; but that is far from the case, and anyway it is a poor kind of remuneration which is given only by means of additional work. For example, Jenner, the great discoverer of vaccination, found that his reputation in this line actually ruined his medical practise; and it was partly for this reason that early last century the British Parliament (which was then a rational and virile body) gave him £30,000 as a reward. The reason for this is that everyone considers a famous discoverer to be only a faddist or a charlatan! Of course many other pursuits which are invaluable to civilization are in precisely the same boat—other branches of science, music, literature and sometimes even painting, travel, etc. Our proposal is that every nation should keep a pension fund for really great work in these lines. We do not suppose that the British Empire would have to pay more than, say, £30,000 annually for such pensions, as against many millions of pounds which it now gives as a subvention for loafing, incompetence, and unemployment.—*Science Progress.*

SPECIAL ARTICLES

A METHOD OF ASSIGNING WEIGHTS TO ORIGINAL OBSERVATIONS

PERSONS accustomed to making precise measurements know that the circumstances attendant upon their work vary to such a degree as to render some observations much more reliable than others. When a series of such results is adjusted, as by averaging the measurements on a single quantity, it is logical that some should be given greater voice in deciding upon the most probable value. This is done by assigning to each observation a number, called its *weight,* which represents the relative degree of reliability of the observation in question. The practical

way of interpreting these weights is to give each observation a number of "votes," so to speak, equal to its weight; that is, to count its result that number of times in making up the average. An observation with weight 5, for example, is considered to be worth five times as much as one with weight 1, whatever that signifies. It merits as much confidence as the average of five observations with weight 1.

If each result to be weighted is actually the mean of a number of similar observations, the weighting is comparatively easy. But we refer to the weighting of the *original* observations; and how is one to decide, without indulging in mere guesswork, what this factor, to be assigned to each of such a series of results, should be?

Probably many scientific observers do not weight their measurements because they do not know how. They know that some results are much more trustworthy than others, but they are at a loss when it comes to expressing *how much* more. It is the purpose of this paper to suggest a simple means whereby any scientific worker may arrive at a consistent practise in this matter.

There are very few people engaged in work involving precise measurement who have not reached, through experience either as teachers or as students, a prety well defined interpretation of the ordinary percentage grades assigned to pupils in school or college. When a boy comes home with a grade of only 72 in grammar, the occasion is not one for congratulation. The whole family knows that 72 stands for poor quality of scholarship, for the reason that the vast majority of pupils are assigned a higher grade than this.

Now, it is not difficult for an observer to assign percentage grades to his experimental results, passing judgment upon them very much as he would upon work done by a student in laboratory or classroom. He may even take separate account of the various factors which may affect the observation, such as weather conditions, visibility, constancy of temperature, etc., and combine all these in estimating the final grade of the result, just as a teacher combines recitations, notebooks, tests and examination in grading a student.

And if, when the several observations of a set have been thus graded, a means is at hand to translate the grades into relative weights, our problem is solved. Such a means is provided by the following considerations.

The *variable* conditions attending the making of measurements, which alone affect their relative weight, are of course fortuitous. The experimenter tries to have everything constant and to maintain a uniformly high standard of precision, just as a marksman tries repeatedly to hit the same target. But he can not control all the conditions, and these fluctuate in accordance with the well-known law of departures, based upon the theory of probabilities.

The theory puts no limit to these fluctuations, and one observation might, theoretically, be a thousand times more reliable than another; but practically no such range need be considered. Probably for most purposes, primarily assigned[1] weights need not go outside the simple scale of integers from 0 to 10; the weight 0 denoting absolute worthlessness (observation to be discarded) and the weight 10 denoting practical certainty. Either of these cases would be extraordinary and of very rare occurrence. The general run of results will vary from a little doubtful to a little more than usually reliable, being situated not far either way from weight 5, the middle of the scale.

When the unit of weight has been chosen with such significance that the distribution is as described, it is possible at once to predict what proportion of observations should, in the long run, have weight 2, what proportion should have weight 3, etc. This is done by means of the *probability integral,* tables of which are given in most books on the theory of errors. These proportions are here given as percentages, accurate to the second decimal place:

[1] This does not apply to weights computed for adjusted values based on long series of observations or upon indirect measurements of connected quantities. In such cases, large and even mixed fractional numbers may be consistently assigned as weights.

Percentage having weight	0	should	be	0.00
“ “ “	1	“	“	0.15
“ “ “	2	“	“	1.54
“ “ “	3	“	“	8.46
“ “ “	4	“	“	23.42
“ “ “	5	“	“	32.86
“ “ “	6	“	“	23.42
“ “ “	7	“	“	8.46
“ “ “	8	“	“	1.54
“ “ “	9	“	“	0.15
“ “ “	10	“	“	0.00

For the present purpose it will be more useful to express these same data in the following form:

Percentage having weight—

0	*or above*	should	be	100.00
1	“ “	“	“	100.00
2	“ “	“	“	99.85
3	“ “	“	“	98.31
4	“ “	“	“	89.85
5	“ “	“	“	66.43
6	“ “	“	“	33.57
7	“ “	“	“	10.15
8	“ “	“	“	1.69
9	“ “	“	“	0.15
10	“ “	“	“	0.00

Now a similar tabulation may be made in the case of grades. An examination of the grades assigned by teachers shows a distribution which, while it is very far from having the bilateral symmetry of the theoretical departure law, nevertheless gives evidence of a somewhat similar continuous relation throughout the range of the assignment. The following data, based on the tabulation of over one hundred thousand grades from a large number of school and college teachers,[2] are probably fairly typical:

Percentage of grades which were—

50	*or above* was	100
55	“ “ “	99
60	“ “ “	98
65	“ “ “	96
70	“ “ “	94
75	“ “ “	89
80	“ “ “	83
85	“ “ “	70
90	“ “ “	56
95	“ “ “	32
100	“ “ “	9

[2] See article by author, “A Standard of Interpretation of Numerical Grades,” *School Review*, Vol. XXV., p. 412, June, 1917.

Let us plot these two sets of data on the same diagram, so that they may be easily compared (Fig. 1). The method of translation from grades to weights may then be made

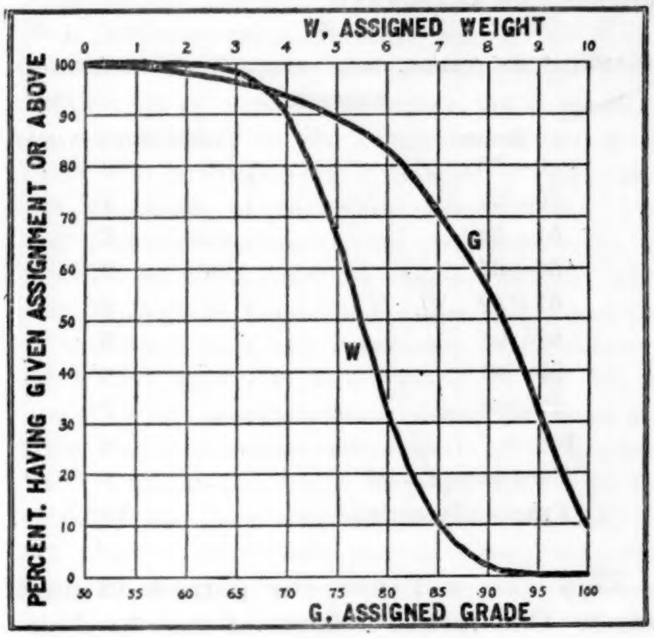


Fig. 1.

clear by a single illustration. The grade curve shows that the grade 85 *or above* is attained in 70 per cent. of all cases, while the

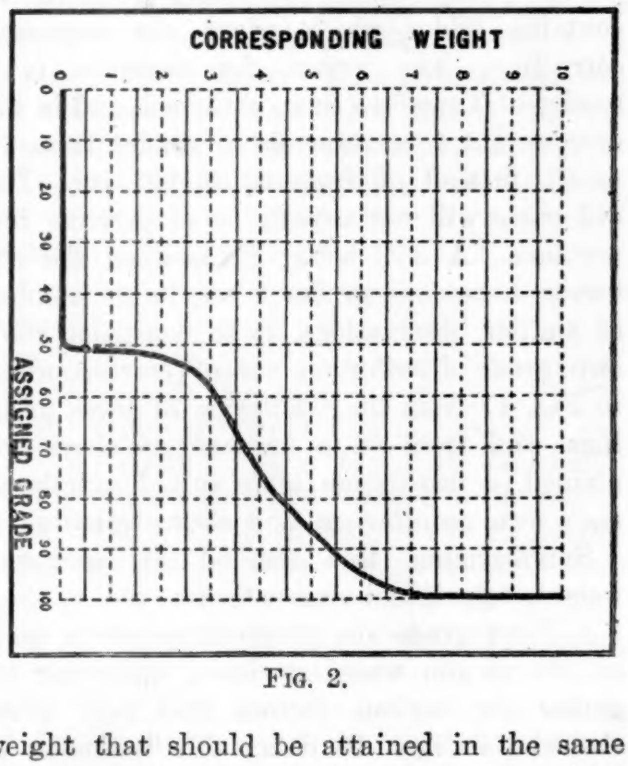


Fig. 2.

weight that should be attained in the same percentage of cases is shown by the weight curve to be 4.9 *or above*. It logically follows that the *grade* 85 corresponds to the *weight* 4.9; etc.

By obtaining a number of such corresponding points, the translation curve (Fig. 2) is constructed. Fractional weights being inconvenient, the most practical tabulation will probably be as follows:

TRANSLATION TABLE FROM PERCENTAGE GRADES TO WEIGHTS

Grades	Corresponding Weight
0– 50	0
50– 51	1
51– 54	2
54– 67	3
67– 82	4
82– 92	5
92– 97	6
97–100	7
100	8
Very exceptional	9
Practically certain	10

This table will serve our purpose in most cases. One further refinement may be desirable, especially if the observer suspects that his own habit in grading is far from normal; that is, if he is inclined to be either unusually severe or unusually lenient in assigning grades. The article previously referred to contains tables which afford the necessary correction. The writer, for example, is a grader of Type 6 as there classified, and in his case weight 5 corresponds to grades from 77 to 88, instead of from 82 to 92; etc. The difference will not usually be of extreme importance. A still better plan, when the observer makes and grades a very large number of similar observations, is to construct one's own grade distribution curve (corresponding to Fig. 1) from the tabulation of these gradings, and from it to prepare, as above explained, a translation table suited exactly to one's own peculiar grading characteristics.

Summarizing this method of assigning weights to original observations:

1. First grade the observations on a scale of 100 as you would students, averaging together the various factors that may affect their reliability. In doing this, endeavor to maintain the same mental attitude toward the experiments as you would toward the work of a class of students.

2. Then consult the above translation table (or one of your own making) for the proper weights to be assigned.

LeRoy D. Weld

Coe College,
Cedar Rapids, Iowa

THE AMERICAN CHEMICAL SOCIETY. III

DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS

H. S. Miner, *Chairman*

H. E. Howe, *Secretary*

Incendiaries used in modern warfare: Capt. A. B. Ray.

Gas masks in the industries: A. C. Fieldner. The Bureau of Mines is cooperating with the industries in the development of suitable modifications of the Army gas mask for industrial use. In the nine months that have elapsed since the signing of the armistice, the gas mask has made rapid progress in finding a wide application in protecting workmen from poisonous and irritating gases given off in various chemical operations; as for example, chlorine, phosgene, sulphur dioxide, oxides of nitrogen, hydrochloric acid, sulphur chloride and many organic vapors as carbon disulphide, benzol, carbon tetrachloride, aniline, chloroform, formaldehyde, etc. Fire departments have purchased many Army masks for use as smoke protectors. However, they must be used with caution around fires, as they given no protection from carbon monoxide, which may be present in smoky atmospheres. The Army gas mask, when fitted with special canister containing ammonia absorbents, has met with great success for use around refrigerating plants. On the whole, the gas mask is rapidly finding its proper place in the industries. It has not met all the requirements expected, especially in such cases where the workmen must wear it for long periods of time. Experience has shown that they simply will not wear a mask continuously if they can possibly get along without it, but for short periods and in emergencies, it has proved very useful. The possibilities of the gas mask principle are now pretty generally understood, and much improvement in design may be expected within the next year.

The physical character of hydrous ferric oxide: Harry B. Weiser.

Modern commercial explosives: R. H. Hill. Paper disputes the war-developed, current idea

that explosives are necessarily connected with matters of a military nature and attempts to furnish a general knowledge of the modern condition of the industry for the busy man who would like such a general idea of it, but does not find time to review lengthy publications. Subjects discussed are black blasting powder, straight dynamites and gelatin dynamites, non-freezing straight dynamites and gelatin dynamites, ammonia or extra dynamites and gelatin dynamites, permissibles, miscellaneous dynamites and non-freezing dynamites. Strength bases are shown and strength comparisons between commercial dynamites and some important military explosives are given. Developments on lowering the freezing point of nitroglycerine are discussed. Mention is made of various matters requiring chemical or physical control in explosive manufacture and the necessity is shown for such control from the initial preparation of ingredients to the final results of the blast.

Chemicals received by the Bureau of Chemistry during the war: H. E. BUC. During the last four years about 1,300 shipments of chemicals from a large number of dealers and manufacturers have been tested in the Bureau of Chemistry. The greater part of the reagents bore an analysis on the label. Most of the chemicals examined are satisfactory. Occasional impurities are found often enough in chemicals from practically all manufacturers to make it necessary to test all shipments.

Report on the production of synthetic organic chemicals in the Research Laboratory of Eastman Kodak Co., 1918 and 1919: C. E. K. MEES.

SYMPOSIUM ON REFRACTORIES, A. V. BLEININGER, CHAIRMAN

The classification of refractories: G. H. BROWN.

Work of the Technical Department of the Refractories Manufacturers' Association: R. M. HOWE. The Refractories Manufacturers' Association has maintained a central refractories laboratory for over two years. This laboratory is located at the Mellon Institute of Industrial Research of the University of Pittsburgh and serves annually over fifty refractories companies. Small charges are made for the work done and this income makes the system practically self-supporting. The problems investigated are divided into two classes, viz., general and specific. The general problems are not discussed, but the specific problems encountered at different plants are considered briefly. These problems are met with from the time of purchasing a site until the shipment of each load of brick. The owners must know the extensiveness of a deposit before opening it up at a large expense. The miners must have abundant advance information concerning the physical properties of the different clays on the property: they must be able to reject or accept different clays by their hardness, color, structure, size of grain and location. The securing of such data requires the expenditure of considerable money, yet it seems to be justified due to the economical selection of clays, the production of a uniform product, and the avoidance of unjustified construction. The clays, after being mined, are used separately, or mixed with bond clays to secure strength; flint clay to increase the refractoriness and resistance to spalling; alumina to increase refractoriness; silica to decrease the tendency to spall and shrink, and grog for several reasons. After the mixes are fixed, they are worked with water. This is sometimes considered a minor step, but it is now established that the *amount* of water used in tempering plays an important part in determining the final structure of the brick. There is always one definite proportion which is most suited to the production of the densest brick. The *time* used in working clay also enacts an important rôle in determining the final structure a variation in strength amounting to 25 per cent. of the total having been observed when the time was varied. Draw trial curves, which illustrate the behavior of clays at different temperatures, are proving to be of value. They not only tell the manufacturer how his clays must be worked but inform the consumers how the bricks will behave in service. Other factors which concern the process of manufacture are too complicated to report but they can be and are being studied constantly.

The selection of refractories for industrial furnaces: W. F. ROCHOW. Economy in the use of refractories is governed by the selection of the class of material best suited for the purpose, the quality of the brick used and the design of the furnace. Thermal insulation is made practicable under severe temperature conditions by the use of silica brick because of their good mechanical strength at high temperatures. On burning, silica brick undergoes partial inversions from quartzite to cristobalite and tridymite. These inversions are accompanied by permanent volume increases. Recently it has been suggested that the lowering of the specific gravity of silica brick on changing from quartzite to the other crystalline forms, be used as a measure of the extent of this transformation and that well-burned brick should have a

specific gravity of not over 2.38. Some quartzites invert to cristobalite more slowly than others and brick with a lesser content of cristobalite have a lower spalling tendency and also do not show an appreciably greater permanent expansion when subjected to long-continued heating. Brick made from this type of quartzite may be properly burned when inversion has occured to such an extent that its specific gravity is slightly greater than 2.38. Examples with analyses are given. Metal-cased magnesite brick consist of steel containers of square or circular cross section, filled with dead burned magnesite. These are laid as headers in the furnaces. When heated the steel fuses and impregnates the magnesite forming a monolithic lining. Such a lining is more porous than one of magnesite bricks and has the advantage of better withstanding rapid temperature changes. Such bricks may be used in place of magnesia and silica brick in parts of the open hearth steel furnace and in electric steel melting furnaces.

Interesting facts concerning refractories in the iron and steel industry: C. E. Nesbitt and M. L. Bell. In this paper the writers state the importance of refractories and emphasize the necessity for their greater efficiency in the iron and steel industry. This improvement can only be accomplished by the cooperation of the producer and the consumer. In the manufacture of iron and steel, refractories meet a wide range of temperature, while destructive agencies such as acid, basic or neutral slags, severe thermal changes, load, abrasion, impact and expansion are present in varying degrees of severity. Tests on refractory brick, easily and rapidly executed, which show a close relation to actual service conditions were developed for determining the resistance to these destructive agencies. The most important working qualities can be determined by two or three tests namely the spalling and hot crushing tests for silica brick, and the spalling, hot load and slagging tests for clay brick. Variations in the life of blast furnace linings, open hearth roofs, converter bottoms soaking pits and ladle linings are mentioned. Results are given showing the marked decrease in crushing strength and increase in spalling of silica brick defective from fire cracks, poor moulding, poor slicking, etc. The writers show the close relationship of the spalling test results with the life obtained in open hearth roofs. The effect of the degree of fineness or size of particles in silica brick is illustrated by results of the spalling test. The effect on certain qualities of clay brick produced by the method of manufacture is illustrated by spalling and load test results. The effect of the degree of fineness and the reduction of strength by heating of clay brick is also shown. From the comparative data it is evident that refractories require most thorough study. Simple practical tests which can be run in quantity and which give data showing variations in quality which reflect on the life of the structure should be adopted. A more uniform product can be secured if a careful study is made of the variations in manufacture which effect the important qualities.

Superior refractories: R. C. Purdy.

Refractory problems in the gas industry: W. H. Fulweiler and J. H. Taussig. In the coal gas process the temperatures range from 400° C. to 1500° C. Rapid changes in temperature and expansion must be considered. Silica material is used in the retorts and the combustion chamber. Fire clay material is used in the recuperators and where the temperature is below 1000° C. In the water gas process the temperature may be 1700° C. in the generator, together with the slagging action due to the ash from the fuel. Abrasion occurring in removing clinker is important. In the carburettor the checker brick are heated to 1200° C. and sprayed with cold oil. Fire clay is used in the generator linings, but other materials are being tried. Cements used in construction frequently do not receive proper attention. Laboratory tests are useful in controlling the quality of materials.

Charles L. Parsons,
Secretary

SCIENCE

A Weekly Journal devoted to the Advancement of Science, publishing the official notices and proceedings of the American Association for the Advancement of Science

Published every Friday by

THE SCIENCE PRESS

LANCASTER, PA. GARRISON, N. Y.

NEW YORK, N. Y.

Entered in the post-office at Lancaster, Pa., as second class matter